July 8 1999 Supercell Event: Radar and TDA Analysis

WFO La Crosse Research Series #7
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I have put together some data from the July 8, 1999 event and also provided some thoughts on the case. I analyzed four main parent storms via the Mesocyclone and TVS alphanumeric products. I looked at the Lewiston tornadic storm, the Mondovi tornadic storm, a long-lived circulation which tracked from Wabasha through Clark county, and the La Crosse county storm.

Although the alphanumeric products maybe aren't as good as objective operator analysis, I think they give some insight into the behavior of the storms *and* the performance of the algorithms. Plus, it saved me about 2 weeks worth of work. There are likely many things to find in this data....I have only noted a few. I would recommend looking at the data tables while reading the bulleted notes for a particular storm below.

General Notes:

- WSR-88D Alphanumeric products in AWIPS are found in the text viewer under PILS WSRnnnARX. The nnn is MES for Mesocyclone output and TVS for the TVS output. Use the browser for ease using REGIONAL and RADAR/UPPERAIR as the Origin and Class for the browser.

- The environment had a very high Wet-bulb Zero height and Freezing Level (15.3 Kft) so severe hail at the surface was hard to produce from these storms.

- When storms move over the radome with circulation moving into the cone of silence, it is best to station someone outside to view the storm. Spotting outweighs the radar data at that point. The storm will be over a city area and stress fairly high in these situations.

- The La Crosse circulation moved into an area of range folding (purple haze) from about 15 nm west of the radar through the radar. This was due to a line of storms over Iowa beyond the first trip velocity length. Recall and review, if needed, the procedure for manually changing the first trip length to try and remove the purple haze. You do this by "Changing the PRF by Specifying the Unambiguous Range" (UCP Help Book Section 16). This may help remove the purple haze. Also, view other elevation slices in the data.

- In this case, the reflectivity data really pulls your eyes to one storm (southeast MN) but the SRM data really pulls you to another (northern Buffalo county). Be careful not to get too hooked on one of these groups to look at the storms. See example images attached for 2320Z.

- Look at the TVS Algorithm statistics. From this single case, the FAR numbers are quite similar to the Wichita findings: 88%. 15 of 17 TVS's did not have a tornado associated with them. Of those 15 TVS's which did not have tornadoes, none of them where TVS's *leading up to* either of the tornadoes. Both of the tornadoes had TVS's given to the operator at the exact time of initial tornado touchdown.

- No ETVS's occurred in this event.

The Mondovi Storm:

- Significant weather from the storm started about 2 hours after first echo. Recall from the "Convective Storm Matrix" PDW module that this depends on the shear and buoyancy balance. The stronger the shear for a given buoyancy, the longer the storms take to mature.

- The MESO algorithm gave indication of the circulation both deepening and lowering toward the surface. Shear values also jumped from 7 to 31 in two volume scans.

- The MESO algorithm output was positive for the operator.

- The TVS triggered at tornado touchdown time. The TVS algorithm was positive for the operator but did not provide lead time. Shear values of 0.032 are moderate-strong.

The Lewiston Storm:

- Significant weather began two hours after radar first echo. However, the tornado occurred about 2 hours after first echo.

- The MESO algorithm had trouble tracking one storm centroid. Via the radar, the parent thunderstorm did appear as a conglomerate of other smaller cells.

- The MESO algorithm did indicate deep rotation extending to the lowest levels about 20 minutes prior to the first funnel report. However, the shear values were not very high at 0.011. The strongest rotation was indicated at the time of initial tornado touchdown. From that point on, the MESO algorithm did indicate low rotation (BASE).

- At 0010Z, storm ID V0 showed up which was located on the southwest flank of the storm. The radar operator would have to interpret these storm ID's in real time and apply them to the alphanumeric product - which is difficult. Later, at 0040Z the MESO gave the strongest shear at the lowest levels but no sig weather was reported except dime-sized hail. At this same time, the La Crosse storm was growing rapidly on the southwest flank of this storm. This may have played a role in altering the Lewiston storm environment.

- The MESO product performed somewhat positive for this case. However, it was misleading after the Lewiston tornado lifted. Knowing the location of the circulation in the storm (FFD,RFD, intersection) is critical to interpreting the data.

- The TVS triggered upon tornado touchdown. However, it also fired earlier and later than the tornado. Overall it was sporadic and continuous usable information was not gained on this storm. The shear values were impressive.

The Wabasha-Clark County Storm:

- This storm provided two hours of a single identified storm ID which indicates a long-lived, near steady state isolated storm. In comparison with the other storms, you would have thought this might be the most damaging storm of all. Not so. In fact, it produced very little weather from what we know.

- The MESO, although long-lived, never produced a stronger rotation than 0.014 or 14 on the MESO output. Compared to Lewiston (0.026) and Mondovi (0.031), it was about one-third the strength.

- The MESO product indicated low shear values (0.006-0.010) for the two reports of wind damage early in the mesocyclone's life. However, there was stronger convergence in the low-levels when the SRM was analyzed.

- The strongest time for this storm was in northern Trempealeau county when 3 TVS's were triggered. Still nothing was found on the damage surveys. Shear was 0.025 with these TVS's which then continued for another 5 scans! This is less than the Mondovi and Lewiston tornado shear. As an operator, you sit with the idea that a long-lived tornado may be on the ground. Ouch. The environment, specifically a more stable near-surface lapse rate, likely played a role in suppressing severe weather.

- The TVS performance was a large negative on this storm leading to an increased FAR.

- The MESO performance was neutral on this storm...it did not indicate big shear but yet didn't allow you to ignore the

storm.

The Houston-La Crosse-Monroe Storm:

- This storm produced interesting radar dilemma problems of range folding and cone of silence. It also was very hard to trace storm ID's in the alphanumeric products which may have been easier in real time. Again here, we saw much of the damage occur about 2 hours after radar first echo.

- The MESO produced shears a bit lower than the Mondovi and Lewiston storms. It appears a good number in the MESO product to remember is 0.025 or 25 shear for significant damaging rotation. From the information gathered, it will not give you the shear values as high as the TVS algorithm. Remember they are different and a MESO does not need to be identified for the TVS to trigger.

- The TVS values were very impressive on this case. Its performance was still not very good. Although likely an error, the shear at 0131Z over Struver's house was .339 or 339. More likely values: Ken C. found a 0.102 shear via V-R shear at 0131Z. These V-R shear values were likely attainable because of resolution near the radar and a very small gate-to-gate distance.

- The TVS first triggered where we started getting reports of damage - just to the east of the office about 830 pm. The BASE was very indicative of what was happening.

- It seems the TVS is helpful in showing the relative magnitude of the shear, but misleading for tornadoes on the ground.

Event TVS Algorithm Verification: (2320-0200Z)

- 17 TVS's Detected (from 4 different parent storms on 15 different volume scans)
- 5 Volume Scans occurred with confirmed tornadoes on the ground
  - 3 Volume scans with NO TVS.
  - 2 Volume Scans with TVS.

Unverified TVS's: 15
Total TVS's: 17
Total Volume Scans with Tornadoes: 5

FAR = 88% (15/17)
POD = 40% (2/5)
CSI= 10% (2/20)

Average Lead Time: **0 minutes.**

*PUP Outage for 2 volume scans of Lewiston Tornado

Mondovi Circulation

Mesocyclone Alphanumeric Product

Radar First Echo: 2130Z

Volume Scan Time	Storm ID	Base (Kft)	Top (Kft)	Hgt (Kft)	Diameter (nm)		Shear (E-3/s)	Observed Weather	Rank of storm in alphanumeric table/Number of storms
					RAD	AZ			
2310Z	I8-MESO	10.5	25.3	25.3	2.2	4.2	7		3/36
2315Z	I8-MESO	5.0	24.8	5.0	2.4	2.5	11		1/36
2320Z	I8-TVS	4.7	24.0	4.7	2.2	2.7	31	Tornado 8SW Mondovi	2/36
2325Z	Pupdown								

TVS Alphanumeric Product

Volume Scan Time	Storm ID	AVGDV (Kt)	LLDV (Kt)	MXDV/HGT (Kt, Kft)	Depth (Kft)	Base/Top (Kft)	MXSHR/HGT (E-3/s,Kft)
2320Z	I8	36	101	101/4.7	>25.	<4.7 / 29.7	32/4.7

Olmsted - Winona Circulation

Mesocyclone Alphanumeric Product Storm Genesis Time: 2130Z

Volume Scan Time	Storm ID	Base (Kft)	Top (Kft)	Hgt (Kft)	Diameter (nm)		Shear (E-3/s)	Observed Weather or Location (*)	Rank of storm in alphanumeric table/Number of storms
					RAD	AZ			
2305Z	V9 -MESO	5.9	22.3	5.9	2.2	2.6	20	Zumbro*	1/24
2310Z	V9-MESO	10.8	16.1	21.2	5.5	5.0	11		4/36
2315Z	V9 -MESO Y9-UNC S	15.3 12.8	24.5 12.8	24.5 12.8	2.7 1.5	5.3 2.3	7 17		4/36 6/36
2320Z	V9-MESO Y9-UNC S	19.4 16.9	23.2 22.5	19.4 22.5	2.0 2.2	3.9 4.0	9 6	2" Hail Elgin*	3/36 5/36
2325- 2340Z	Pupdown								
2345Z	M4-MESO	4.1	21.7	9.1	4.2	5.6	7		1/55
2350Z	M4-MESO	3.7	25.0	12.4	3.6	4.1	11		1/50
2355Z	M4-TVS	4.0	25.2	21.2	2.8	3.0	12		2/57
0000Z	M4-MESO M4b-MESO	3.7 7.4	23.8 24.8	23.8 7.4	1.8 2.3	3.8 2.4	9 13		1/63 4/63
0005Z	M4b-MESO	3.1	25.1	21.5	2.0	2.4	14	Funnel Altura*	1/61
0010Z	M4b-MESO V0-UNC S	6.2 6.8	22.6 6.8	16.3 6.8	3.2 1.3	3.7 3.0	13 14	FFD Flank RFD Flank	4/62 10/62
0015Z	M4b-MESO V0-MESO	2.7 6.5	23.9 25.6	23.9 16.1	2.6 1.8	2.7 2.3	12 13		2/67 5/67
0020Z	V0-TVS	2.4	23.8	17.0	4.0	2.9	26	Tor - Lewiston	1/60
0025Z	M4b-MESO V0-MESO	2.0 7.9	23.7 15.9	17.3 15.9	5.9 1.5	3.1 2.1	12 9	Tor - Lewiston	3/61 4/61
0030Z	M4-MESO	1.8	25.3	25.3	5.8	2.3	24	Tor-Lewiston	1/57
0035Z	M4b-MESO	1.6	24.5	14.9	4.5	2.5	17		1/57
0040Z	F2-TVS	1.5	22.4	19.6	1.9	2.0	30	Nodine* Dime Hail	1/57
0045Z	F2-MESO	3.1	16.6	12.3	3.5	2.9	22		2/65
0050Z	D6-MESO	2.7	23.7	10.0	2.6	2.2	28		1/59
0055Z	D6-MESO	6.7	8.7	6.7	1.9	2.4	18	N of Holmen	4/60

TVS Alphanumeric Product

Volume Scan Time	Storm ID	AVGDV (Kt)	LLDV (Kt)	MXDV/HGT (Kt, Kft)	Depth (Kft)	Base/Top (Kft)	MXSHR/HGT (E-3/s,Kft)
2355Z	M4	26	60	58/3.5	>24.5	<3.48/28.3	23/3.8
0020Z*	V0	40	63	78/2.3	>15.0	<2.3/25.0	41/2.3
0030Z*	M4b	28	35	70/26.9	>29.4	<1.9/31.3	45/26.9
0040Z*	F2	37	46	101/7.3	>29.4	<1.4/30.9	85/7.3

* indicates a time gap

Wabasha - Buffalo - Trempealeau - Jackson - Southern Clark Circulation

MESO - Alphanumeric Product Radar First Echo: 2130Z

Volume Scan Time	Storm ID	Base (Kft)	Top (Kft)	Hgt (Kft)	Diameter (nm)		Shear (E-3/s)	Observed Weather or Location (*)	Rank of storm in alphanumeric table/Number of storms
					RAD	AZ			
2300Z	T4 -MESO	5.9	22.8	22.8	3.0	4.6	8	Wabasha Cty*	1/32
2305Z	T4 -MESO	21.0	26.2	21.0	1.9	4.6	6	Wind Damage	3/24
2310Z	T4 -MESO	10.6	16.1	16.1	2.6	5.1	6		2/36
2315Z	T4 -MESO	4.8	25.7	20.2	4.6	3.7	10	Wind Damage	2/36
2320Z	T4 -MESO	4.6	24.7	24.7	2.4	3.0	12	Buffalo Cty*	1/44
2325-2340Z	Pupdown								
2345Z	T4	Non-significant rotation - 2nd spinup beginning							
2350Z	T4 - 3DC SHR	15.7	19.5	19.5	1.9	3.1	6		7/50
2355Z	T4 - UNC SHR	3.6	3.6	3.6	2.4	2.9	8		8/57
0000Z	T4-MESO	3.3	7.8	3.3	3.2	3.0	9	Trempeal Cty*	2/63
0005Z	T4-TVS	3.4	7.9	3.4	3.4	2.7	13		2/61
0010Z	T4-TVS	3.4	12.1	3.4	2.7	3.5	13		1/62
0015Z	T4-TVS	3.3	16.6	3.3	3.4	2.8	13	Jackson Cty*	3/67
0020Z	T4-MESO	7.7	20.4	7.7	4.2	3.1	11		4/60
0025Z	T4	Non-significant rotation detected by meso algorithm, TVS was identified.							
0030Z*	T4-MESO	3.1	11.6	3.1	6.5	3.2	12		3/57
0035Z	T4-MESO	3.4	12.0	3.4	5.9	3.7	14		2/57
0040Z	T4-MESO	3.4	16.1	7.4	3.2	3.5	13	Clark Cty*	2/57
0045Z	T4-MESO	3.3	16.6	12.3	3.5	2.9	13		1/57
0050Z	T4-MESO	3.1	15.2	7.6	2.2	2.9	14		3/59
0055Z	T4-MESO	3.3	7.7	3.3	5.3	3.9	8		1/60
0100Z	T4-UNC S	3.2	3.2	3.2	2.0	4.2	5	Wind Damage	3/68

Volume Scan Time	Storm ID	AVGDV (Kt)	LLDV (Kt)	MXDV/HGT (Kt, Kft)	Depth (Kft)	Base/Top (Kft)	MXSHR/HGT (E-3/s,Kft)
0005Z#	T4	31	63	63/3.4	>8.5	<3.4/11.8	25/3.4
0010Z#	T4	28	55	55/3.3	>8.2	<3.3/11.5	23/3.3
0015Z#	T4	36	51	63/7.8	>8.1	<3.4/11.5	25/7.8
0025Z* -	T4	28	52	52/3.2	>8.0	<3.2/11.1	22/3.2
0035Z*	T4	30	54	54/3.1	>12.0	<3.1/15.1	23/3.1
0040Z	T4	29	50	50/3.0	>8.0	<3.0/11.1	21/3.0
0045Z	T4	30	61	61/3.2	>7.9	<3.2/11.1	25/3.2
0050Z	T4	40	71	71/3.2	>8.2	<3.2/11.5	29/3.2

# indicates circulation was surveyed for damage
* indicates a time gap.

Houston - La Crosse - Monroe Circulation

Mesocyclone Alphanumeric Product — Storm Genesis Time: 2335Z

Volume Scan Time	Storm ID	Base (Kft)	Top (Kft)	Hgt (Kft)	Diameter (nm)		Shear (E-3/s)	Observed Weather or Location of Storm *	Rank of storm in alpha-numeric table/Number of storms
					RAD	AZ			
0020Z	D7-UNC S	3.4	3.4	3.4	4.2	2.9	8	NW Houston County*	9/60
0025Z	D7-MESO	9.0	12.1	12.1	2.2	2.3	17		5/61
0030Z	D7-MESO	9.5	16.0	14.2	1.5	2.0	12		4/57
0035Z	D7-MESO D7-3DC S	18.6 4.5	21.5 12.1	18.6 12.1	2.3 2.6	2.2 2.8	12 9		6/57 8/57
0040Z	D7-MESO	8.5	20.0	18.1	2.3	2.7	17		3/57
0045Z	E4-MESO	6.3	25.8	13.0	3.0	2.0	16	Golfball Hail	3/65
0050Z	E4-MESO	3.5	25.1	6.8	3.0	2.2	25	N Town of Houston*	3/59
0055Z	D7-MESO C5-MESO C5-UNC S	5.9 3.0 1.0	21.4 10.0 1.0	18.7 10.0 1.0	3.6 1.5 1.9	2.2 1.7 1.3	18 15 76	FFDowndraft-,75 Hail RFD RFD	3/60 2/60 5/60
0100Z	E4-MESO C5-MESO	14.1 4.9	17.6 12.1	17.6 8.0	2.6 1.9	2.0 1.5	17 19	FFD - .75 Hail RFD	2/68 1/68
0110-0131Z	Cone of silence								
0136Z	F7-TVS	15.4	17.7	17.7	2.2	1.7	23	Coming out of cone G72, Wind Damage	1/49
0141Z	W7-MESO	5.6	8.4	5.6	1.8	1.4	25	Barn destroyed, trees down	1/54
0146Z	F7-MESO W7-TVS	3.6 13.8	8.0 22.8	6.4 13.8	1.8 1.2	2.8 2.0	27 19		3/55 5/55
0151Z	P9-TVS W7-MESO	1.0 16.0	4.2 24.1	2.7 16.0	2.3 2.8	3.0 1.6	59 24	RFD/FFD occlusion New FFD/RFD occ.	1/63 3/63
0156Z		4 - F7 MESOs identified - algorithm broke the one MESO into many MESOs.							

TVS Alphanumeric Product

Volume Scan Time	Storm ID	AVGDV (Kt)	LLDV (Kt)	MXDV/HGT (Kt, Kft)	Depth (Kft)	Base/Top (Kft)	MXSHR/HGT (E-3/s,Kft)
0136Z	F7	69	25	130/2.3	5.2	0.8/6.0	339/2.3
0146Z*	W7	45	56	97/3.4	>11.3	<0.8/12.0	122/3.4
0151Z	P9	45	98	102/2.4	>29.7	<0.9/30.6	116/2.4
0156Z	L2	44	49	78/4.4	>8.1	<1.0/9.1	77/4.4

Nearest Storm ID	Time	AZ (deg)	RAN (nm)	Storm Report	AZ (deg)	RAN (nm)	Alg. Result
I8	23:20	328	51	Tornado Begin Time	331	49	Hit
Pupdown	23:25			Tornado	331	49	-
Pupdown	23:30			Tornado	332	50	-
Pupdown	23:35			Tornado End Time F1	333	50	-
M4	23:55	286	44				FA
M4	23:55	292	42				FA
P0	00:10	294	38				FA
V0	00:20	289	30	Tornado Begin Time	288	32	Hit
	00:25			Tornado	288	31	Miss
M4	00:30	297	26	Tornado End Time F2	287	31	Miss
F2	00:40	302	21				FA
T4	00:05	348	40				FA
T4	00:05*	352	40				FA
T4	00:10*	356	40				FA
T4	00:15*	356	40				FA
T4	00:25	6	38				FA
T4	00:35	15	38		287	31	FA
T4	00:40	18	37				FA
T4	00:45	21	39				FA
T4	00:50	26	39				FA
	01:26			G72 - NWS	0	0	Miss#
F7	01:31	99	5	Wind Damage	100	3	FA#
	01:36			Wind Damage	101	6	Miss#
	01:41			Wind Damage	101	9	Miss#
W7	01:46	105	12	Wind Damage	102	11	FA#
P9	01:51	100	14	Wind Damage	104	12	FA#
L2	01:56	102	16	Wind Damage	103	15	FA#

* Surveyed complete mesocyclone rotation track (via GPS mapping software). No damage. Electric Company did a flyover and noted no damage nor outages from this T4 storm.

Surveyed as non-tornadic intense downburst winds associated with the mesocyclone.

According to write-up above and NSSL document guidelines:

A = 2 (Hits)
B = 2 (Misses)
C = 17 (FA)
D = Was not completed

POD = 2/4 = 50%
FAR = 17/19 = 89%
Miss Rate = 2/4 = 50%
CSI = 2/21 = 10%

Revised TVS algorithm performance using <u>wind damage</u> as TVS verification:

A = 6 (Hits)
B = 5 (Misses)
C = 17 (FA)
D = Was not completed

POD = 6/11 = 55%
FAR = 17/23 = 74%
Miss Rate = 5/11 = 45%
CSI = 6/28 = 21%